CLEANING THE BAYSIDE FILTERS[1]

By E. G. Manahan

The writer has been asked to say a few words regarding the methods used in cleaning the Bayside filters. The notice of this meeting states, however, that "filter troubles" are to be discussed. Bayside filters and troubles have at times been considered to be nearly synonymous terms; but in looking back over these troubles they seem to have been largely the result of too great expectations. However, such troubles as were had led to a study and comparison of methods of cleaning which may be of some interest.

The Bayside filters are small, slow sand filters, belonging to the Department of Water Supply, Gas and Electricity of the city of New York, and are located in the Borough of Queens, about 15 miles from the city hall. They furnish between one and two million gallons daily, and were put in service in the summer of 1911. During the writer's brief stay with that department, they came under his observation, and to some extent under his control.

The filters are five in number, and together have an area of about one-third of an acre. They are not covered, but are formed by dividing a long concrete lined basin having sloping sides into five parts by means of concrete cross walls. They differ from most filters in that they were designed to be cleaned by the Brooklyn method. This method, as is well known, consists in drawing the water on the bed down to within an inch of the sand, and then causing water to flow across the bed from one end to the other while the sand is being raked by men standing on the surface. Since by this method removal of the sand from the bed for cleaning is not required, the depth of sand provided in these filters is only 26 inches, instead of the more customary 4 feet. For admitting the wash water and taking it away, there are channels along the inlet and outlet ends of the filters, cut into the sloping sides of the basin with their tops at the elevation of the sand line. Wooden partitions, driven into the sand, extend longitudinally over the beds between these channels, dividing the

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filter surface into bays about 11 feet wide, and of the length of the bed. By blocking off the other bays, one bay at a time may be cleaned.

It was intended that the filters should be operated at relatively high rates, and therefore the sand is as coarse as could be obtained without unduly increasing its cost. It has an effective size of about 0.35 mm., and a uniformity coefficient of about 2.1. The filters are provided with loss of head gauges and rate controllers, thus obviating attendance at night. In other respects than those mentioned above the filters are in accord with generally established practice.

The water supply is taken by gravity from Oakland Lake, nearby. This lake is fed largely from underground sources, although considerable surface wash reaches it from adjacent steep slopes. The water is therefore ordinarily of good character, and the turbidity low, averaging about 6 parts per million, and seldom exceeding 12. Except during the first summer, no serious trouble has been experienced from microörganisms, although these are at times numerous and copper sulphate has been used to a slight extent in certain parts of the lake. The bacteria run low, averaging perhaps 100; and B. coli, though generally found in 10 cc. samples, is generally absent in 1 cc. Purification is reasonably satisfactory, though not always so when the filters become very dirty. Turbidity and microörganisms are generally entirely removed, and bacteria and B. coli are substantially reduced.

In the spring of 1912, when the filters had been in service more than half a year, the writer was directed by Mr. I. M. deVarona, then chief engineer, to study, in conjunction with Mr. John A. Byrne, then borough engineer of Queens, the question of cleaning the filters so as to get as high a yield as possible. Because of early troubles from microörganisms or for some other reason, the filters had generally been cleaned up to that time by scraping the sand surface and piling the scraped material on the banks. They had been giving reasonably satisfactory yields during the winter; but in the spring it was found impossible after a time to run them for more than a few days between successive cleanings, either by scraping or by the Brooklyn method.

The filters had been running at a rate of filtration of 350,000 gallons each daily, or about 5,000,000 gallons daily, and it was desired to increase this rate. When the filters were designed, it was apparently expected that, with the Brooklyn method, which is rapid

and requires less than a day's time, and with water of very low turbidity, rates perhaps as high as 10,000,000 gallons daily might be maintained.

In the spring of 1912, it was very difficult, with the Brooklyn method, to maintain the 5,000,000 gallon rate. It was thought that the hard crust which was found to form just below the depth reached by the garden rakes used might be responsible for the difficulty, and this was doubtless true to a certain extent. In order to break up this crust, clam rakes, having teeth about 6 inches long, were employed. Handling these rakes was slow, hard work, and the gain was not commensurate. Turning over the sand to a depth of 8 or 10 inches by spading helped considerably, but this was even slower than the use of clam rakes.

The trouble was probably due as much if not more to insufficient cleaning of the sand by the Brooklyn method, since less difficulty was experienced when the beds were cleaned by scraping instead of the Brooklyn method. But on account of lack of proper facilities for washing sand, it could not be replaced, and the continual removal without replacement was objectionable, not only because the original depth of the sand was small, but because lowering the sand level meant increasing the depth of water flowing over the sand while cleaning by the Brooklyn method, thus reducing the velocity of the wash water and interfering materially with its efficiency.

While we were struggling with this state of affairs the situation was somewhat relieved by an apparent improvement in the quality of the raw water. It has since then always been noticed that, during the summer, and particularly during the winter, the runs between cleanings have been comparatively long, while during the fall and especially during the spring, the runs have been comparatively short. No conclusive cause for this is found by inspecting the analyses of the raw water, but it may be due to the character of the amorphous matter stirred up by the overturning of the lake, though the lake in many parts is not very deep.

Since it was necessary to have a sand washer of some kind anyway, and since the use of a machine would enable the immediate replacement of the sand, a sand washer and an ejector hopper for handling the sand were purchased. Also, two other methods of cleaning were attempted, with a view to improvement over the Brooklyn method.

One, suggested by the then division engineer, Mr. T. C. Atwood,

was called the "jet" method. After first removing the heaviest of the deposit on the sand by going over the bed once with the back of the rake, as in the Brooklyn method, then, instead of proceeding to go over the bed again, using the teeth of the rake, which is the final process in the Brooklyn method, the operator, standing upon the surface of the bed over which the wash water is flowing, directs a stream of water from a hose nozzle down into the sand. Such a jet appears to soften and cleanse the sand quite well. The operator can tell by the feeling of the sand beneath his feet whether it has been washed or not, as he will sink in where it has been washed.

Another method, suggested by Deputy Chief Engineer Brush, was called the "water rake" method. The apparatus used is in the form of a rake, with handle, head and teeth of wrought-iron pipe. The teeth are about 4 or 5 inches long, closed at the ends, and perforated with $\frac{1}{8}$ inch holes. A curved sheetiron plate or shoe, placed under the head, serves to support the rake when placed on the sand. Water under pressure introduced through a hose connected at the upper end of the handle is discharged in numerous jets under the sand surface, and as the rake is moved along by the operator, this water cleanses the sand and is carried away by a stream of water passed over the bed as in the Brooklyn method. Previously to using the water rake, the heaviest part of the surface deposit is usually removed with the back of the garden rake, as described under the jet method. The results attained by the use of the water rake, both in cleansing and in softening the sand, are reasonably satisfactory.

It was later determined to make comparative tests as to the economy of the four available methods of cleaning, by using each method exclusively upon a single bed. In carrying out the tests, as is frequently the case, some irregularities occurred, and hence the writer will not attempt to give definite figures. A brief statement regarding the results may, however, be of interest. It is not claimed, of course, that these results are applicable necessarily to other filters or to other waters.

It was quickly found to be entirely impracticable to use the Brooklyn method alone continuously, as the length of runs gradually became very short. Therefore, the sand washing machine was used once or twice after four or five cleanings by the Brooklyn method. The cleaning of this filter was carried out in a more irregular manner than that of any of the others, and this filter appeared to show the highest cost and the lowest yield.

The attempt to use the water rake was soon abandoned. Figures for the first runs made seemed to show that it was unduly expensive, although this was later shown to be untrue. The rake, as designed, was difficult to operate, because, when the operator kept it moving slowly enough to allow the sand to become softened, he had great difficulty in keeping the rake from sinking into the sand. Also, on account of lack of facilities for turning off the water at the rake, the jets made the work disagreeable to the operator whenever the rake was removed from the water, especially during cold weather. The handling of the long line of hose behind the rake also involved considerable labor. The writer believes that it would have been possible to have designed a rake which would have done work superior to that accomplished by the Brooklyn method, and that would not have sunk into the sand; but believes that such a rake would not have any advantage over the simpler jet method.

The jet method is probably cheaper than any of the others. The operators like it fully as well as the Brooklyn method, as the hard work is done by the jet of water, and the operator merely holds the nozzle and moves the hose, which is easier than using the teeth of the garden rake. The bed has to be out of service somewhat longer than with the Brooklyn method, unless more than one jet of water is available. An apparent objection is that care has to be used to be sure that all parts of the bed have been uniformly subjected to the action of the jet, although there is no evidence of any trouble from such a source. The method can be used to soften the sand to any desired depth, and might well be used, in the writer's opinion, in place of the customary deep scraping, as the sand is well washed in place.

As to the continuous use of scraping and the sand washing machine, compared with the use of the Brooklyn method aided by the machine when necessary, the continuous use of the machine appears to be cheaper. The men like it better, as they can keep dry and there are no troubles from leaky boots. The sand washing machine alone is cheaper whenever long runs are desirable, as in the winter, and also when the water is particularly foul. The combination of the two methods is probably cheaper when the water is in good condition, as in the summer, if microörganisms are not abundant.

The tests were made with a rate of filtration in all cases of approximately 5,000,000 gallons daily, but there has been no particular

difficulty with the comparatively large force of men available for cleaning purposes, in maintaining, by either the sand washing machine method, the machine and Brooklyn methods combined or by the jet method a rate of 7,000,000 gallons daily, which is more than the capacity of the water shed of the lake in dry periods.

For obtaining the greatest total yield at the least cost, it appears to the writer that a combination of methods which was not tested is best; that is, a combination of the jet method and the sand washing machine. The jet method cleans the sand to a considerable depth, and keeps it soft; while the use of the sand washing machine keeps the surface layer clean, and, especially at times when there are large quantities of organic matter present in the raw water, does more thorough work in the upper layer than the jet can accomplish. By the use of the jet deep scrapings can be avoided, for the discoloration of the sand extends very little below 2 inches; and it is the deep scrapings that add materially to the cost of the sand washing machine method at Bayside, especially as the foreman seems to be tempted, whenever men are available and the demand for water not pressing, to scrape as deep as the time permits.

At Bayside, as generally elsewhere, the Brooklyn method has an advantage in point of cost, in that the wash water is raw water which has not been pumped, while with any of the other methods described it is necessary to use pumped filtered water for washing. This advantage, however, does not, in the writer's opinion, make the cost of the Brooklyn method as low as that of the jet method.